



Course Title: Embedded Systems & Networking: PIC Microcontrollers and Data Communication Networks

Course Length: 3 days, in-person

Time in Class per day (hours): 6 hours of in-person instruction and lab time

Labs: 6 total, 2 per day, 15 hours total

Delivery Options: Company site or at provider

Class Size: Minimum 15 / Maximum 30

Price Per Student: \$475.00

Location: Wayne County *or* Company Site

Day 1: 4 hours of lecture, and 2 hours of labs (Lab 1 and Lab 2) – See below for lab exercises

Day 2: 4 hours of lecture, and 2 hours of labs (Lab 3 and Lab 4) – See below for lab exercises

Day 3: 2 hours of lecture, and 4 hours of labs (Lab 5 and Lab 6) – See below for lab exercises

Course Description:

This short course aims to present principles of data communications and real time embedded systems networking. PIC18F microcontroller family and multiple serial interfaces including USART, CAN bus along with other embedded standards will be introduced. Students will become familiar with the microcontrollers and communication networks through practicing multiple Lab activities. Examples of current embedded systems used in vehicles and future developments for CAV (connected and autonomous vehicles) will be discussed.

Prerequisite:

Individuals wanting to take this course should have basic knowledge of the topics of digital design as well as micro and programmable controllers.

Course Learning Objectives:

Upon completion of this course participants will be able to:

- Be familiar with PICDEM 2 Plus Demo Board and MPLAB IDE integrated development environment
- Modify and test a program using PIC18F microcontroller
- Be familiar with PICDEM NET2 (Ethernet, TCP/IP) and Zigbee (wireless) network environment
- Be familiar with Controller Area Network (CAN) protocols and frames.
- Demonstrate competence in extensive research on one of the embedded networking topics for life-long learning
- Specify, design, implement, and debug an embedded system project



Course Content/Topics:

Introduction to Embedded Systems and Networking

- Introduction to microcontrollers
- Applications in automobiles (ABS, navigation, telematics, and airbag etc.)

Data Communication Networks

- Digital Signals: bit interval, bit rate, and baud rate
- Synchronous vs Asynchronous communication

Serial Communication Interfaces

- RS232
- I2C (Synchronous Serial Communication Interface)
- USB (Universal Serial Bus)

Introduction to PIC 18F Microcontroller

- PIC 18 Development Tools
- PIC 18 Serial Communications Interface

Ethernet Protocol

- Transmission Control Protocol/Internet Protocol (TCP/IP) Protocol
- Internet Connectivity over an Ethernet connection

Wireless Zigbee standard

- Microchip Zigbee stack
- Wireless Zigbee network setup

Controller Area Network (CAN)

- PIC 18 CAN Module
- CAN Message Formats
- Arbitration
- Error Handling
- CAN Kingdom

Examples of Embedded systems in vehicles

- ABS
- Airbag
- Future development for CAV (connected and autonomous vehicles)

Labs:

1. INTRODUCTION TO MPLAB ICD2 AND PICDEM 2 PLUS –A/D Converter

- This exercise is an implementation of the PIC18F452 analog-to-digital converter using the PICDEM 2 Plus Demo Board. The program configures the A/D module to convert input from A/D channel 0 (connected to the potentiometer on the demo board) and display the result on the four PORTB LEDs.

2. INTRODUCTION TO MPLAB ICD2 AND PICDEM 2 PLUS –LCD Lab



- This laboratory exercise will help students run a sample program which uses the LCD panel on the PICDEM 2 Plus Demo Board. Students will need to make some adjustments on the program so that R4 and R0 buttons can read the menu of the display and choose an option to view the voltmeter, buzzer, temperature, and the clock.
3. INTRODUCTION TO MPLAB ICD2 AND PICDEM 2 PLUS –Scrolling LCD
 - This laboratory exercise is an extension of the previous laboratory exercise. Students are asked to modify the program(s) so that they can write the words they wish to scroll on the LCD.
 4. INTRODUCTION TO THE PICDEM NET2 DEVELOPMENT ENVIRONMENT
 - This laboratory exercise allows students to develop internet connectivity applications over an Ethernet connection using embedded Microchip controllers over Ethernet and the Internet. Students will get familiar with the Microchip TCP/IP (Transmission Control Protocol/Internet Protocol) Stack architecture. They will learn to work with IP addresses and will access a website that came with the demo program. This is a continuation of the previous exercise where the students are asked to change a website and/or create their own website.
 5. INTRODUCTION TO PICDEM Z DEVELOPMENT ENVIRONMENT
 - This laboratory exercise will demonstrate a Zigbee wireless network setup. A major component involved is the Microchip Zigbee Stack used to carryout software protocol handshaking. The Zena Wireless Network Analyzer will be used as a network traffic monitor.
 6. CONTROLLER AREA NETWORK (CAN) LABORATORY_1 – UNDERSTANDING CAN PROTOCOL AND FRAMES USING CAN-LIN3 EVALUATION BOARD
 - This laboratory exercise allows students to see how the CAN-LIN1 board operates and how the software (CAN Kingdom) is used to control and process CAN messages. Students are able to see and understand CAN messages and locate the identifier, data length, and the value of the data injected onto the bus using the output window of the software.

MAGMA short courses are held on a rolling basis, based on industry demand. Please complete this [short form](#) to express interest for yourself, or your organization.